

2011
MECHANICAL ENGINEERING (Optional)
(Paper – I)

450041

Standard : Degree

Total Marks : 200

Nature : Conventional (Essay) type

Duration : Three Hours

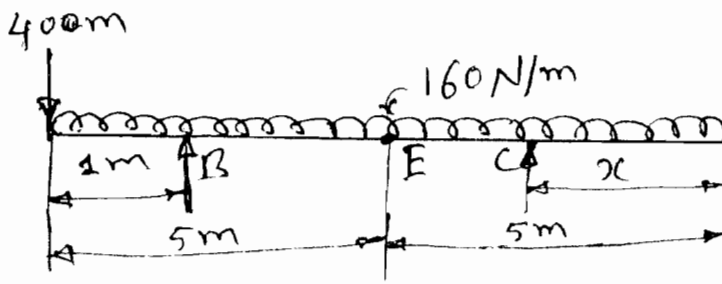
N.B. :

- 1) Answers must be written in English.
- 2) Question No. 1 is **compulsory**. Of the remaining questions, attempt any four selecting one question from **each Section**.
- 3) Figures to the **RIGHT** indicate marks of the respective question.
- 4) Use of log table, Non-Programmable calculator is permitted, but any other Table/Code/Reference book are not permitted.
- 5) Make suitable assumptions, wherever be necessary and state the same.
- 6) Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.
- 7) Credit will be given for orderly, concise and effective writing.
- 8) Candidates should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he/she will be penalised.

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1. (a) A horizontal beam AD, 10 meters long carries a uniformly distributed load of 160 N/m together with a concentrated load of 400 N at the left end A. The beam is supported at a point B which is 1 m from A and C which is on the right hand, half of the beam and x meters from the end D.



Determine the value of x, if the mid-point is a point of contraflexure and for this arrangement draw S.F. and B.M. diagrams.

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- (b) A conc clutch is used to connect an electric motor running at 1440 rpm with a machine which is stationary. The machine is equivalent to a rotor of 150 kg mass and radius of gyration as 250 mm. The machine has to be brought to

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- the full speed of 1440 rpm from stationary condition in 40 seconds. The semicone angle is 12.5° . The mean radius of the clutch is twice the face width. The coefficient of friction is 0.2 and the normal intensity of pressure between contacting surfaces should not exceed 0.1 N/mm^2 . Assuming uniform wear criteria, calculate :
- (i) the inner and out diameters
 - (ii) the face width of the friction lining
 - (iii) the force required to engage the clutch
 - (iv) the amount of heat generated during each engagement of clutch.
- (c) (i) What are defects in casting due to improper moulding and what are corresponding remedial measures to overcome them ? 5
- (ii) Discuss the causes of residual stresses in welding. How they can be controlled ? 5
- (d) What are the key characteristics of Bezier curve and B-spline curve ? 10
- (e) Explain "Linear programming – an useful tool for OR" with suitable examples. 10

SECTION – A

2. (a) Find the least force required to drag a body of weight W placed on a rough inclined plane having inclination α to the horizontal. The force is applied to the body in such a way that it makes an angle θ to the inclined plane and the body is :
- (i) on the point of motion up the plane and
 - (ii) on the point of motion down the plane.
- Also find the efficiency of the inclined plane in each case. Assume force applied is P . 15
- (b) A four cylinder vertical engine has cranks 300 mm long. The planes of rotation of the first, third and fourth cranks are 750 mm, 1050 mm and 1650 mm respectively from that of the second crank and their reciprocating masses are 150 kg, 400 kg and 250 kg respectively. Find the mass of the reciprocating parts of the second cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. Use graphical method. Draw couple polygon and force polygon. 15
- (c) (i) Give detail classification of steel. State the properties, applications and IS specifications of the following steels with examples.
- (a) Tool steel
 - (b) Stainless steel
 - (c) High speed steel. 5

- (ii) The equation for the deflected shape of a beam carrying a uniformly distributed load and simply supported at the ends is given by

$$y = \frac{1}{EI} \left[2x^3 - \frac{x^4}{6} - 36x \right]$$

Determine the load carried by the beam and draw S.F. and B.M. Diagrams for the beam. The unit of EI is KN/m².

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3. (a) Prove that the efficiency of a screw jack of raising a load W depends on the angle of friction and helix angle of screw and is independent of the weight lifted. Further prove that the maximum efficiency of the screw is given by

$$\eta_{\max} = \frac{1 - \sin\phi}{1 + \sin\phi} \text{ where } \phi - \text{angle of friction.}$$

If a screw jack has a square thread with 7.5 cm mean diameter and 1.5 cm pitch, the load on the jack revolves with the screw and the coefficient of friction at the screw threads is 0.05,

- (i) Find the tangential force to be applied to the jack at 36 cms radius so as to lift a load of 600 N.
- (ii) State whether the jack is self locking.
- (b) A rear engine automobile is travelling along a track of 100 meters mean radius. Each of the four road wheels has a moment of inertia of 2.5 kg.m² and an effective diameter of 0.6 m. The rotating parts of the engine have a moment of inertia of 1.2 kg.m². The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3 : 1. The automobile has a mass of 1600 kg and has its centre of gravity 0.5 m above road level. The width of the vehicle is 1.5 m.

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Determine the limiting speed of the vehicle around the curve for all four wheels to maintain contact with the road surface. Assume that the road surface is not cambered and centre of gravity of the automobile lies centrally w.r.t. the four wheels.

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- (c) (i) Suggest a suitable material with proper justification for the following components. Give the IS designation, composition, properties, manufacturing method and the heat treatment processes to be carried out
- (a) Crankshaft of a multicylinder I.C. engine
- (b) Piston of a four stroke engine of two wheeler
- (c) I.C. engine cylinder block.

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- (ii) A water main of 500 mm internal diameter and 20 mm thick is running full. The water main is of cast iron and is supported at two points 10 m apart. Find the maximum stress in the metal. The cast iron and water weigh 72000N/m^3 and 10000N/m^3 respectively.

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SECTION - B

4. (a) Discuss various theories of failure applicable to elastic failure of machine parts.

A shaft is supported in bearings 4 m apart and transmits 60 KW at 160 rpm. At 1.2 m from one bearing the shaft carries a pulley transmitting a load of 50 KN on the shaft. Find the suitable diameter for the shaft for each of the following cases :

- (i) The maximum direct stress shall not exceed 120N/mm^2 .
 (ii) The maximum shear stress shall not exceed 60N/mm^2 .
 (iii) The stress acting alone to produce the same maximum strain shall not exceed 120N/mm^2 .
 (iv) The stress acting alone to store the same maximum strain energy per unit volume shall not be exceed 120N/mm^2 .

From all the above considerations, suggest the suitable minimum shaft diameter to be adopted.

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- (b) Differentiate between hydraulic and pneumatic systems along with their applications.

Classify various types of control valves used in hydraulic systems. Draw the following hydraulic circuits with label and state the applications of each of them.

- (i) A sequence circuit
 (ii) Meter-in circuit with integral check valve
 (iii) Regenerative circuit.

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- (c) A machine of mass 10 kg is supported on springs and dashpots. The total stiffness of springs is 5N/mm and total damping is 0.075N/mm/s . The system is initially at rest and a velocity of 100m/s is imparted to the mass.

Determine :

- (i) Whether the system is over-damped, under-damped or critical-damped,
 (ii) The displacement and velocity of mass as a function of time,
 (iii) The displacement and velocity after one second.

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5. (a) A pressure vessel consists of a cylindrical shell with torispherical ends. The Crown and the Knuckle radii of torispherical end closure are $\left(\frac{3}{4}D\right)$ and $\left(\frac{1}{8}D\right)$ respectively where D is the diameter of the cylindrical shell. Derive an expression for the volume of end closure in terms of diameter of the shell. Assume that the thickness is negligibly small compared with the overall dimensions of the shell and end closures.

If the capacity of this vessel is 10 m^3 and the length is limited to 5 m and the vessel is subjected to an operating pressure of 0.5 MPa. The yield strength of the plate material is 200 N/mm^2 and the corrosion allowance is 2 mm. The weld joint efficiency can be taken as 0.6. Determine :

- (i) the diameter of the cylindrical shell
- (ii) the length of the cylindrical shell
- (iii) the crown radius
- (iv) the knuckle radius
- (v) the thickness of the cylindrical shell
- (vi) the thickness of the torispherical ends.

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- (b) State the advantages , disadvantages and limitations of pneumatic system with applications. Explain with neat sketch the function of a 'FRL' unit in pneumatic system.

Draw the following pneumatic circuits with label and state their applications :

- (i) Time delay circuit
- (ii) Quick exhaust circuit
- (iii) Impulse operation circuit.

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- (c) The crank and connecting rod of a petrol engine, running at 1800 rpm are 50 mm and 200 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1 kg. At a point during the power stroke, the pressure on the piston is 0.7 N/mm^2 , when it has moved 10 mm from the inner dead centre. Determine :

- (i) Net load on the gudgeon pin
- (ii) Thrust in the connecting rod
- (iii) Reaction between the piston and cylinder
- (iv) The engine speed at which the above values become zero.

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SECTION - C

Marks

Answer the following sub-questions :

6. (a) In an orthogonal cutting process the following data were observed

Chip length = 70 mm

Uncut chip length = 175 mm

Rake angle = 18°

Depth of cut = 0.5 mm

Horizontal component of cutting force = 2100 N

Vertical component of cutting force = 210 N.

Determine : shear plane angle, chip thickness, friction angle, resultant cutting force.

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(b) (i) Describe analytic and qualitative methods of forecasting.

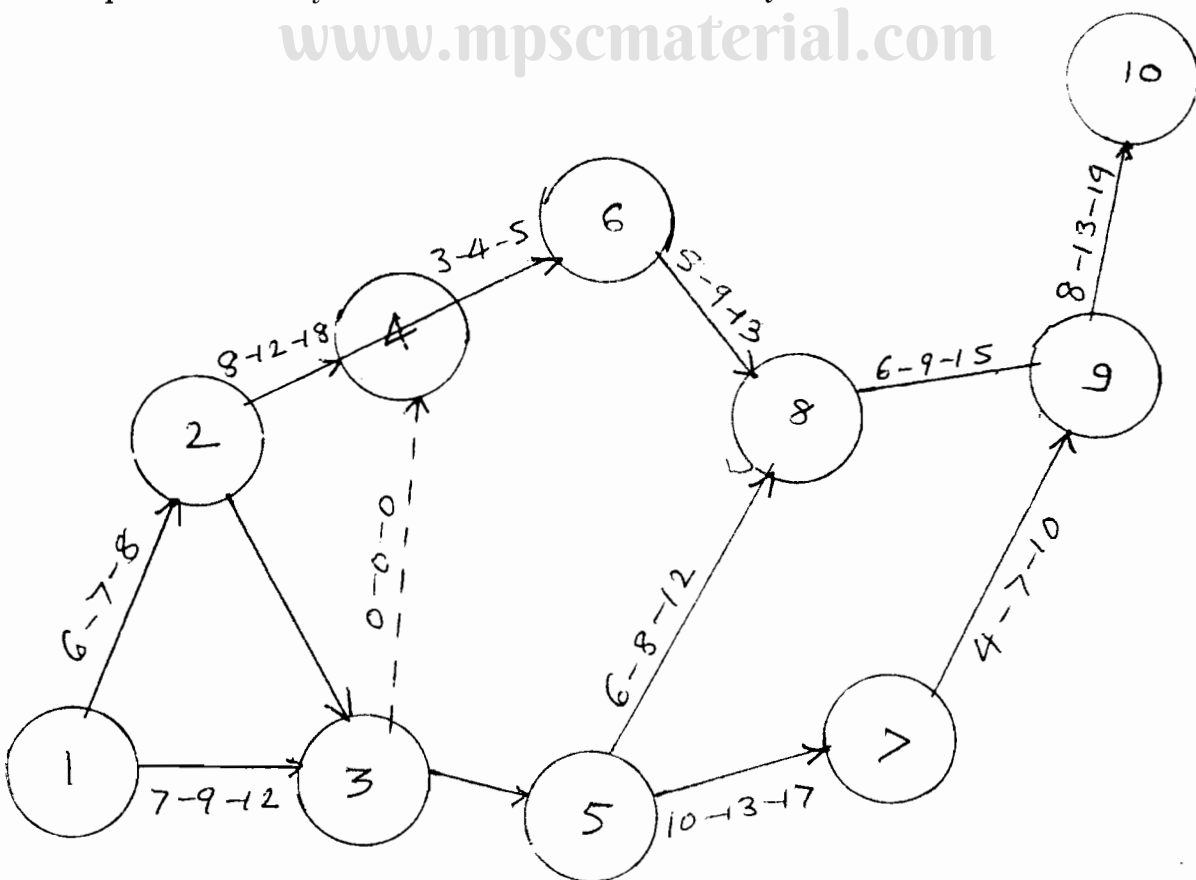
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(ii) What are principle objectives of TQM ? Compare ISO 9000 and TQM.

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c) In the network as shown below the three time estimates (namely optimistic most likely, pessimistic) for each of the activities are indicated in sequence. If 1 is the start event and 10 is the end event, determine the critical path based upon most likely time estimate for each activity.

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7. Answer the following sub-questions :

- (a) Make a brief summary of relationships between various angles and forces as per Merchant's analysis of metal cutting. What is merchant's constant ? Draw self explanatory figures. 15
- (b) A company has to purchase items A, B, C and D for three years. The projected demand and unit price (in Rs.) is as follows :

Item	Demand (units)	Unit price (Rs.)
A	50,000	3.0
B	40,000	2.0
C	12,000	7.0
D	7,500	11.0

If the company wants to restrict total number of orders to 40 for all the four items, how many orders should be placed for each item ? 10

- (c) A company has 3 manufacturing plants situated in 3 cities A, B and C with production capacity of 2,000, 6,000 and 7,000 units per week. These units are to be transported to 4 distributing centres D, E, F and G with absorption capacity of 3,000, 3,000, 4,000 and 5,000 units per week respectively. The transportation cost (per product) from plant to distribution centres are given below (in Rs.).

To →	D	E	F	G
From ↓				
A	13	11	15	20
B	17	14	12	13
C	18	18	15	12

Work out the optimum scheme giving the minimum transportation cost. 15

SECTION – D

8. Answer the following sub-questions :

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|--------|--|----|
| (a) | Explain the steps in carrying out the value engineering study. | 10 |
| (b) | A 2×2 drive is required to be designed for transmitting 10 HP with speeds ranging from 400 r.p.m. with $\phi = 1.4$. Draw the feasible structural forms and possible ray diagrams. Select a suitable structural form and optimum ray diagram. | 15 |
| (c) | (i) Describe the types of layout used in FMS with suitable sketches. | 6 |
| | (ii) What are the different technologies used in CIM ? | 9 |
| 9. (a) | Explain the morphology of design. | 10 |
| (b) | (i) What do you understand by static and dynamic rigidity of a machine tool ? What are the factors that influence static and dynamic rigidity ? | 7 |
| | (ii) If total load amounting to 15 KN is supported by guides on both sides taken together and the viscosity of the oil used is 0.067 Ns/m^2 and minimum oil film thickness is taken as $2 \times 10^{-5} \text{ m}$, find the breadth of the guide, assuming table moving with a velocity of 30 mm/s and the intensity of guide pressure not to exceed 0.05 N/mm^2 . Also calculate the length of the table required. | 8 |
| (c) | (i) Define industrial robot. What are the common robot configurations ? | 7 |
| | (ii) Differentiate between conventional process planing and CAPP. | 8 |

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